
System architecture

This section gives a high level description of Meridian 1 architecture, emphasizing those components of the system which have capacity limitations or impacts. After reading this section, the reader should have a general understanding of the role which each major component of the system plays in handling calls and other switch functions.

A Meridian 1 is a digital system which provides switching of voice and data calls. The “circuit-switching” method is used, which means that a circuit is established for each call, and dedicated to that call for its duration. It is called a “digital” switch because, in general, the messages which are used to establish and tear down circuits are digital packets, rather than analog signals. It is a digital system because it uses a computer, or “central processor,” to control its functions.

The hardware of the Meridian 1 is divided into the following functional areas (see [Figure 3](#)):

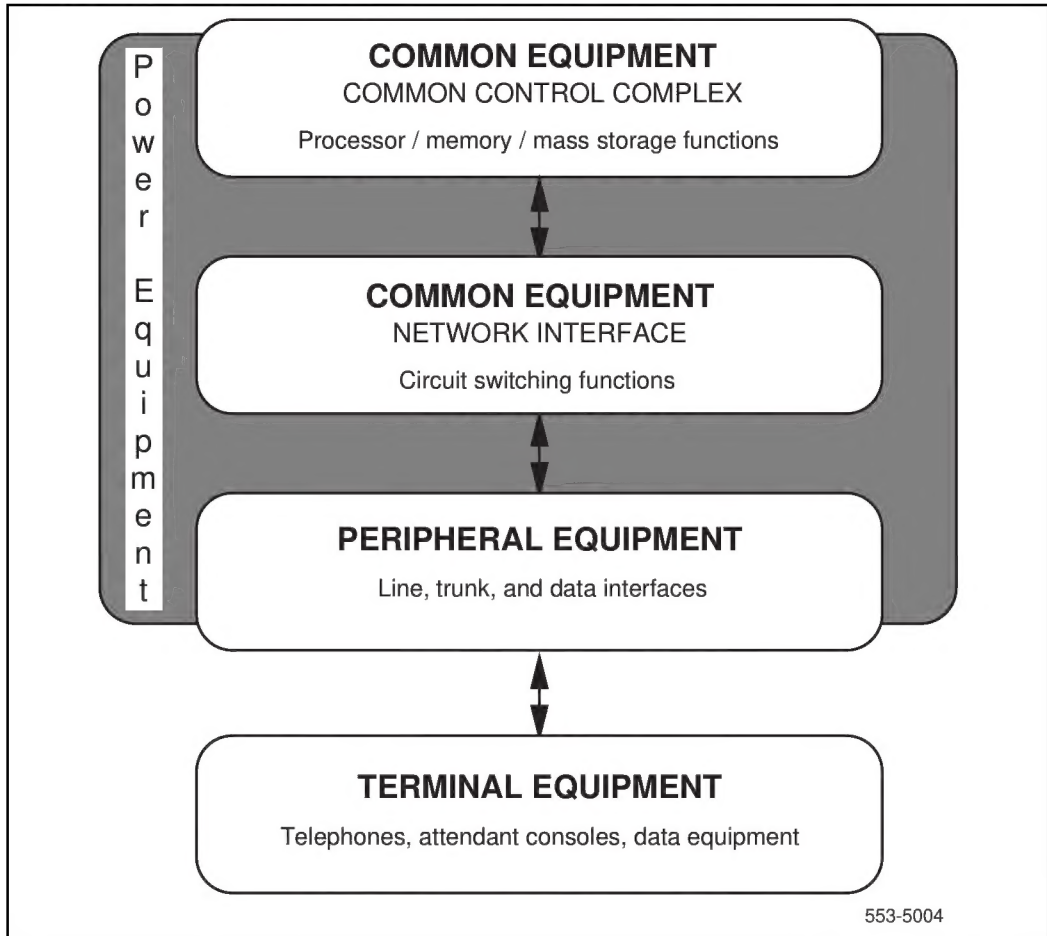
- Common equipment circuit cards provide the processor control, software execution, and memory functions of the system.
- Network interface circuit cards perform switching functions between the processor and peripheral equipment cards.

Note: As shown in [Figure 3](#), the network interface function is generally considered a subset of the common equipment functions.

- Peripheral equipment circuit cards provide the interface between the network and connected devices, including terminal equipment and trunks.
- Terminal equipment includes telephones and attendant consoles (and may include equipment such as data terminals, printers, and modems).

- Power equipment provides the electrical voltages required for system operation, and cooling and sensor equipment for system protection.
- Auxiliary equipment includes separate computing platforms that provide additional functionality which interfaces with and sometimes controls the activities of the switch's main processor.

Figure 3
Meridian 1 basic architecture



Common equipment

The central processor is the common control complex of the system. It executes the sequences which process voice and data connections, monitor call activity, and perform system administration and maintenance.

The processor communicates with the network interface over a common control bus that carries the flow of information.

The common control complex consists of:

- the processor card or cards that provide the computing power for system operation
- system memory that stores all operating software programs and data unique to each system
- the disk drive unit that provides mass storage for operating programs and data
- I/O interfaces that provide an information exchange between the user and the system

Central processing unit (CPU)

At system power-up, prestored instructions are executed by the CPU to begin the process of loading programs from the system's mass storage device into memory. The program's first activity is to read in the site's configuration database from mass storage. Once the system loading and initialization process is complete, the program enters its normal operational state.

During normal operation, the CPU performs control and switching sequences required for call processing, system administration and maintenance, and processes input/output messages which provide interfaces to auxiliary processors and the system administrator. Each of these activities is controlled by a preprogrammed sequence of instructions. The CPU is capable of executing a limited number of these instructions in a given time period. This number depends on the processing power of the CPU. Four processor options are available to give the user a range of capabilities. [Table 2](#) shows the system options which use each of these processors, and gives the approximate relative power of the CPUs in arbitrary units.

Table 2
Relative power of Meridian 1 CPUs

System Type	CPU Power Relative to option 71	CPU Power Relative to option 81 w/NT6D66 CP
Option 11E*	0.25	0.12
Option 11C	2.48	1.17
Option 21, ST*	0.20	0.09
Option 21E, STE*	0.88	0.42
Option 51, 61, 71, RT, NT, XT*	1.00	0.47
Option 51C, 61C, 81, 81C (w/NT6D66 CP card)	2.12	1.00
Option 51C, 61C, 81, 81C (w/NT9D19 CP card)	3.33	1.57
Option 51C, 61C, 81, 81C (w/NT5D10 CP card)	4.43	2.09
Note: Option 11E, 21, 21E, 51, 61, 71, and the SL-1 ST, STE, RT, NT, XT are not supported in Release 22 and higher.		

Some system options provide redundant CPU and memory components. Using a special device known as a CPU and Memory Arbitrator (CMA), each CPU is connected to both memory banks. The active CPU writes status changes to both memories and each CPU can read from either memory. If the active CPU fails, the backup CPU is activated. If the active memory fails, the same CPU continues to operate, but operates using the backup memory.

System memory

System memory contains all software programs and data required by the main processor. Four types of solid-state memory are used: Flash Electronically Programmable Read-Only Memory (Flash EPROM), Read-Only Memory (ROM), and Dynamic Random-Access Memory (DRAM).

ROM is permanently programmed memory (firmware) housed on a CPU daughterboard. This memory stores basic instruction interpreters, firmware procedures for operating system functions such as arithmetic and memory access, and the bootstrap procedures necessary to initialize the system and bring it into a working state. ROM also stores the recovery, or trap, sequence which is automatically activated at power-up, system reload, or when certain faults are detected.

Flash EPROM is introduced with the Thor CP2 (NT9D19 CP card) systems in Release 21B and the option 11C in Release 22. It is used to store code (i.e. bootstrap code, OS, call processing code and any other application code).

DRAM is dynamic writable memory contained in chips which may be located on a separate memory board, or, for some systems, on the CPU board itself. It is volatile, that is, its contents are lost when power is disconnected. Therefore, its contents must be restored from nonvolatile memory (mass storage) whenever power is lost, the system is reloaded, or certain faults occur.

On the NT6D66 CP card, DRAM is divided into three functional areas:

- Unprotected data store (UDATA) holds constantly changing, unprotected data (such as call registers, call connection, and traffic data) required during call processing.
- Protected data store (PDATA or office data) holds protected customer-specific information (such as trunk configuration and speed call data).
- Program store holds call processing programs, input/output procedures, programmed features and options (such as conference and call transfer), and diagnostic and maintenance programs.

On the NT9D19 and NT5D10 CP cards, and Option 11C, DRAM is divided into the following functional areas:

- Unprotected data store (UDATA) holds constantly changing, unprotected data (such as call registers, call connection, and traffic data) required during call processing.
- Protected data store (PDATA or office data) holds protected customer-specific information (such as trunk configuration and speed call data).
- Dynamic OS Heap space for OS and for certain SL-1 features (MAT, Mobility, MMIH, QSIG, PRI) to allocate as needed during run time.
- SL-1 patching area
- Miscellaneous fixed OS requirements.

Program store holds call processing programs, input/output procedures, programmed features and options (such as conference and call transfer), and diagnostic and maintenance programs.

Memory and storage: option 11E

The memory and storage mechanism in option 11 differs from other Meridian systems. The software is provided through the software cartridge inserted into the COMBO pack which replaces the existing CPU/CONF, TDS/DTR, and XTD packs.

In the COMBO memory area, there are 128k words (256kB) Udata, 128k words Pdata and 256 bytes flash ROM. When the expansion daughterboard is equipped, an additional 128k words Udata and 128k words Pdata can be added. This makes the software accessible up to 256k words Udata and 256k words Pdata.

Memory and storage: option 11C

Option 11/11E software cartridges are no longer used on 11C. Instead, PCMCIA drive cards are used for software delivery, patch delivery, and external data storage for optional feature data. (e.g., the Mobility feature is one feature that makes provisions for using this space).

ROM is provided on CPU daughterboards. The initial daughterboard provides 24MB of flash for program store and 8MB for the “disk emulator” memory which is used for SL-1 Pdata, PSDL, patches, package and network data, and SL-1 logging. At present there is only this one daughterboard. If more ROM is needed, an additional daughterboard may be added.

Mass storage

Mass storage devices (floppy disks and fixed head rotating disks) are used to permanently store information required by the Meridian 1 main processor and peripherals. The floppy disk medium is used to deliver this information to the site, and to save site-specific data periodically as it is updated. On some systems a hard disk is used as a back up for floppies, and as a time saving mechanism.

At system power-up or during a system reload, protected data store, program store information, and peripheral device software are automatically transferred from the disk drive unit to the system memory or peripheral devices. During regular operation, the CPU accesses information from the memory.

If information in protected data store is changed (such as a change in a telephone configuration), the information on the disk drive unit must be updated. Transferring data from the system memory to the disk drive unit is called a data dump. Data dumps can occur automatically or manually (through software program commands).

The following types of disk drive units are used in Meridian 1 systems:

— NT8D68 Floppy Disk Unit (FDU):

- used in options 21, 51, and 61 with X11 release 15–17 (for option 71, can be used with release 15 only)
- two 3.5-inch floppy disk drives with a formatted capacity of 1.44 MB each; 2.88 MB total

— NTND15 FDU:

- used in option 21E with X11 release 18 and later
- two 3.5-inch floppy disk drives with a formatted capacity of 2.88 MB each; 5.76 MB total

- NT8D69 Multi Disk Unit (MDU):
 - used in options 51, 61, and 71 with X11 release 15-17
 - two 3.5-inch floppy disk drives with a formatted capacity of 1.44 MB each; 2.88 MB total
 - one 3.5-inch hard disk
- NTND16 MDU:
 - used in options 51, 61, and 71 with X11 release 18 and later
 - two 3.5-inch floppy disk drives with a formatted capacity of 2.88 MB each; 5.76 MB total
 - one 3.5-inch hard disk
- NT6D64 Core Multi Drive Unit (CMDU):
 - used in option 51C with X11 release 20 and later
 - used in option 61C with X11 release 19 and later
 - used in option 81 with X11 release 18 and later
 - one 3.5-inch floppy disk drive with a formatted capacity of 2.88 MB
 - one 3.5-inch hard disk
- NT5D61 Input/Output Disk Unit with CD-ROM (IODU/C):
 - used in options 51C, 61C, 81, 81C with X11 release 23 and higher
 - one 3.5-inch floppy disk drive with a formatted capacity of 1.44 MB
 - one 3.5-inch hard disk
 - one CD-ROM drive (the NT5D61BA vintage does not have a CD-ROM drive)

Note: On the option 81, two CMDUs, one in each core module, are used in a redundant arrangement. Therefore, 2.88 MB of floppy disk storage and 120 MB of hard disk storage are available during operation.

Input/output interfaces

Input/output (I/O) ports provide an interface between the system and external devices, such as terminals and teletypewriters, and application module link (AML) applications, including Meridian Mail and Meridian Link. The I/O devices may be located at local or remote sites.

Prior to X11 release 18, a total of 16 I/O ports could be configured per system. With X11 release 18 and NT6D80 Multi-purpose Serial Data Link (MSDL) Cards, a maximum of 64 I/O ports is supported (there are four ports per card; up to 16 cards can be configured). However, the maximum number of AML ports supported remains at 16.

Several types of I/O ports are available, each with its own unique protocol and bandwidth characteristics. The bandwidth of an I/O port may constrain the amount of information which can be exchanged over that link.

Network equipment

The network is a collection of paths over which voice and data information can be transmitted. The Meridian 1 network is digital, meaning that the voice and data information is encoded in digital form for transmission. These digital signals are multiplexed together on a physical entity called a “loop.” Each path or “channel” on a loop is identified by its “time slot,” which signifies the order in which the data is placed on the loop during the multiplexing operation.

Loops transmit voice, data, and signaling information over bidirectional paths between the network and peripheral ports (that is, two channels are allocated for each conversation, one in each direction). The network is designed so that any terminal can be connected, through proper assignment of time slots, to any other (functionally compatible) terminal on the system. The technology used is called space switching and time division multiplexing.

The use of transmission channels in the switch is known as “traffic.” Traffic is generated by terminals (sets and trunks). Each loop or superloop has a capacity for traffic which is a function of the number of time slots available, and the blocking level which the user is willing to accept. Blocking is the probability that a caller will not be able to complete a call because there is no time slot available at the particular time it is needed. The higher the traffic, the higher the blocking. A typical acceptable level of blocking is P.01, which means .01% of all calls (1 in 10,000) will be blocked, on the average.

Network cards

Network cards are the physical devices which digitally transmit voice and data signals. Network switching also requires service loops (such as conference and Tone and Digit Switch [TDS] loops) which provide call progress tones and outpulsing.

Two types of cards provide network switching control:

- The NT8D04 Superloop Network Card provides four loops grouped together in an entity called a superloop.
- The QPC414 Network Card provides two loops.

Network organization

On most Meridian 1 system options, network loops are organized into groups. A system is generally configured as one of the following:

- a half-group system that provides up to 16 loops
- a full-group system that provides up to 32 loops
- a multiple-group system that provides up to 160 loops

An additional switching stage is required between groups in multiple-group configurations. This switching stage, an extension of the originating and terminating network loops, is provided through the intergroup switch cards in Network Modules and the junctor board in the InterGroup Module.

Peripheral equipment

Peripheral equipment refers to the hardware devices that connect ports (lines and trunks) to the network (loops). Since most ports have analog voice channels, and the network is digital, peripheral equipment cards must convert the signals received from ports from analog to digital.

A process called pulse code modulation (PCM), is used to convert analog signals to digital signals before switching is performed by the network. This conversion method samples the amplitude of the analog signal at a rate of twice the highest signal frequency, then converts the amplitude into a series of coded pulses. For telecommunications, the PCM-sampling frequency standard is 8 kHz.

Compressing-expanding (companding) PCM is a standard technique for using 8-bit words to efficiently represent the range of voice and data signals. Two standards for companding, A-Law and μ -Law, are recognized worldwide. Meridian 1 intelligent peripheral equipment conforms to both standards; the standard required is selected through software.

There are two types of peripheral equipment, associated with the two types of network loops described above. Peripheral equipment (PE) cards are supported by QPC414 Network Card loops. Intelligent peripheral equipment (IPE) cards are supported by NT8D04 Superloop Network Card loops.

PE cards are housed in the NT8D13 PE Module. IPE cards are housed in the NT8D37 IPE Module or the NT8D11 CE/PE Module. PE and IPE cards cannot be mixed within a module.

Intelligent peripheral equipment includes:

- controller cards that provide timing and control sequences and monitoring capabilities
- analog and digital line and trunk cards that provide interfaces to equipment outside the modules (such as telephones, data terminals, and trunks)

[Table 3](#) lists the IPE cards and the number of terminations each supports.

Each equipment card contributes traffic to the network. The traffic required by a peripheral equipment card is the sum of the traffic generated by the ports (sets or trunks) serviced by the card. The traffic requirements of all peripheral equipment cards provisioned on a particular network loop must match the traffic capacity of that loop.

Table 3
Intelligent peripheral equipment

Intelligent peripheral equipment cards	Number of terminations
Controller cards:	
NT8D01 Controller card-4	N/A
NT8D01 Controller card-2	N/A
Line cards:	
NT8D02 Digital Line card	16 to 32
NT8D03 Analog Line card	16
NT8D09 Analog Message Waiting Line card	16
Trunk cards:	
NT8D14 Universal Trunk card	8
NT8D15 E&M Trunk card	4
Note 1: Terminal number (TN) density per segment is 16 to 128 TNs, with 64 to 512 TNs per IPE Module. The maximum TN density assumes all slots are equipped with NT8D02 Digital Line Cards with 16 voice and 16 data TNs provisioned. A typical mix of line and trunk cards yields a nominal density of 64 TNs per segment, 256 TNs per IPE Module. Note 2: The NT8D03 Analog Line Card was replaced by the NT8D09 Analog Message Waiting Line Card as of January 1992.	

Remote Peripheral Equipment

In addition to supporting peripheral equipment cards collocated with the common equipment, Meridian 1 systems may be configured to support Remote Peripheral Equipment (RPE). Depending on the type of transmission media required between the host site (Meridian 1 system) and the remote site and the type of peripheral equipment cards selected, the following RPE products are supported:

- Remote Peripheral Equipment
- Carrier Remote IPE
- Fiber Remote IPE
- Fiber Remote Multi-IPE

Each of these remote products allow the peripheral cards to be located remotely from the host system. In the case of Remote Peripheral Equipment (RPE) and Carrier Remote IPE, these products allow the system network interface to be converted and transported across commonly used T1 or E1 digital facilities including digital microwave radio. The Fiber Remote IPE and Fiber Remote Multi-IPE products provide the same network conversion requirements, but transported use fiber facilities instead of T1 or E1. All of these products offer the remote users the same level of feature functionality provided to the local users. Essentially, these remote products allow the remote peripherals to function as if they were collocated with the local peripheral equipment.

For more information, refer to the *Remote Services Guide*.

Terminal equipment

Meridian 1 supports a wide range of telephones, including multiple-line and single-line telephones, as well as digital telephones with key and display functions and data transmission capabilities. A range of options for attendant call processing and message center applications is also available. In addition, a number of add-on devices are available to extend and enhance the features of telephones and consoles. Add-on devices include key/lamp modules, lamp field arrays, handsets, and handsfree units.

Digital telephones

In digital telephones, analog-to-digital conversion takes place in the set itself, rather than in the associated peripheral line card. This eliminates attenuation, distortion, and noise generated over telephone lines. Signaling and control functions are also handled digitally. Time compression multiplexing (TCM) is used to integrate the voice, data, and signaling information over a single pair of telephone wires.

For applications where data communications are required, Meridian 1 digital telephones offer an integrated data option that provides simultaneous voice and data communications over single pair wiring to a port on a digital line card.

Meridian 1 supports the following digital telephones:

- The M2006 single-line telephone has one line key and five programmable feature keys, and can connect to an optional data module.
- The M2008/M2008HF standard business telephone has eight programmable line/feature keys and an optional display, and can connect to an optional data module. The M2008HF can be software-assigned with handsfree communications
- The M2016S secure telephone prevents the telephone from being used as a passive listening device in any environment in which confidential information is discussed. The M2016S has 16 programmable line/feature keys and an optional display, and can connect to an optional data module.
- The M2216 Automatic Call Distribution (ACD) telephone comes with dual headset jacks that enable high-volume call handling capability for telemarketing needs. Model 1 has two RJ-32 ports for modular electret headsets; Model 2 has one RJ-32 port for an electret supervisor headset and one PJ-327 port for a carbon agent headset. The M2216 has 16 programmable line/feature keys and a standard display, and can connect to an optional data module.
- The M2317 intelligent telephone has a built-in liquid crystal display, 11 programmable line/feature keys, and 5 soft keys for access to numerous features, including step-by-step prompts for optional Meridian Mail voice messaging. The M2317 can connect to an optional data module.
- The M2616 performance-plus telephone has 16 programmable keys. The M2616 can be software-assigned with handsfree communications. Optional key expansion modules can extend this telephone to provide 38 to 60 line/feature keys. The M2616 can have an optional display and can connect to an optional data module.
- The M3000 Touchphone has a touch-sensitive liquid crystal display that provides access to many features, including a customized directory of more than 250 dial-by-name entries. The M3000 can also connect to an optional data module.

Attendant consoles

Meridian 1 attendant consoles (M1250 and M2250) provide high volume call processing. Indicators and a 4 x 40 liquid crystal display provide information required for processing calls and personalizing call answering. Loop keys and Incoming Call Identification (ICI) keys allow the attendant to handle calls in sequence or to prioritize answering for specific trunk groups. An optional busy lamp field provides the attendant with user status.

Meridian attendant consoles support attendant message center options. The attendant console can be connected to an IBM® PC or IBM-compatible personal computers to provide electronic directory, dial-by-name, and text messaging functions. All call processing features can be accessed using the computer keyboard.

Power equipment

Meridian 1 provides a modular power distribution architecture.

Each column includes:

- a system monitor which provides:
 - power, cooling, and general system monitoring capabilities
 - error and status reporting down to the specific column and module
- circuit breaker protection
- a cooling system with forced air impellers which automatically adjusts velocity to meet the cooling requirements of the system
- backup capabilities

Each module includes:

- an individual power supply unit with shut-off (switch or breaker) protection
- a universal quick-connect power wiring harness which distributes input voltages and monitor signals to the power supply

All options are available in both AC-powered and DC-powered versions. The selection of an AC- or DC-powered system is determined primarily by reserve power requirements and existing power equipment at the installation site.

Although AC-powered and DC-powered systems have different internal power components, the internal architecture is virtually identical. AC- and DC-powered systems differ primarily in the external power components.

AC power

AC-powered systems require no external power components and can plug directly into commercial AC (utility) power. AC-powered systems are especially suitable for applications that do not require reserve power. They are also recommended for small to medium sized systems that require reserve power with backup times ranging from 15 minutes to 4 hours.

If reserve power is required with an AC-powered system, an uninterruptible power supply (UPS), along with its associated batteries (either internal or external to the unit), is installed in series with the AC power source (see [Figure 4](#)). AC-powered systems that do not require long-term backup can benefit from a UPS with short-term backup because the UPS typically provides power conditioning during normal operation, as well as reserve power during short outages or blowouts.

DC power

DC-powered systems are available as complete systems, with external power equipment provided by Northern Telecom; these systems can also be equipped for customer-provided external power.

DC-powered systems always require external rectifiers to convert commercial AC power into the standard -48 V dc required within the system (see [Figure 5](#)). Batteries are generally used with DC-powered systems, as the traditional telecommunications powering method is for the rectifiers to continuously charge a bank of batteries, while the system power “floats” in parallel on the battery voltage. However, batteries are required only if reserve power is needed.

Figure 4
External AC-power architecture with reserve power

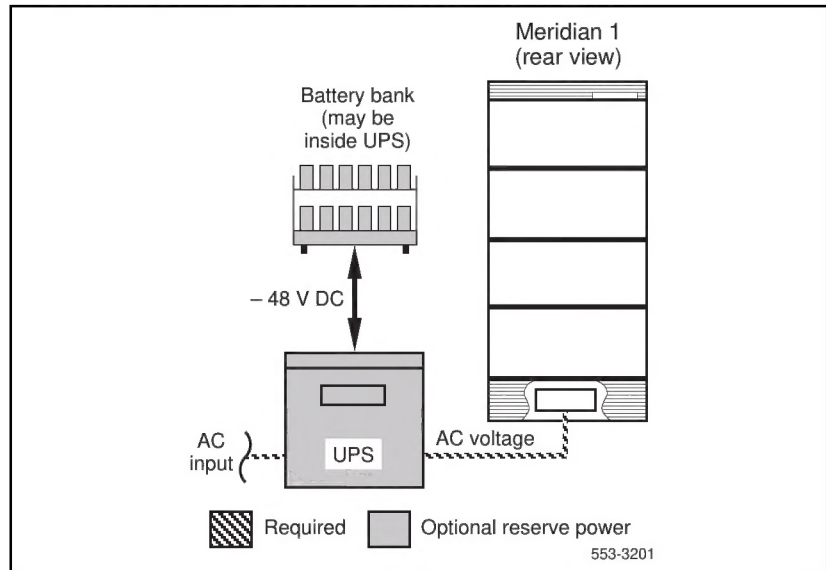


Figure 5
External DC-power architecture with reserve power

